The Use of Honey in Bread Products[1]

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HONEY has been used by man for thousands of years and remains the only natural ready-to-eat sweet in existence. It is mentioned in the Bible many times, and has always been highly esteemed for its sweetness and flavor. As early as 3,000 B.C., beekeeping was standard practice along the Nile river. Since honey comes to us as a food rich in lore and unequaled as a natural source of sweetening power, it is only natural to assume that the use of honey in food manufacture would be desirable.

Except in time of war, the baking industry has used honey in only limited quantities. The reasons for limited use may be several. It is generally believed that the natural variations common to honeys of various floral and locality sources in part are responsible for the reluctance of the baking industry to use honey. The importance of this natural variation in honey composition and flavor as it affects the properties of baked goods have not been previously investigated. Because honeys of various sources are variable in composition, aroma and flavor, it is likely that certain honeys are better adapted for specific types of bakery products. The published literature gives little information on the relation of floral source to suitability for specific types of products. Furthermore, although federal grades for honey exist, those grades have not been correlated with specific usage in the baking industry.

Another problem associated with the use of honey in today's bakery is that of handling. Honey is at present stored and shipped in 5-gallon (60-pound) metal cans. These containers necessitate additional labor and expense by the baker in order to eliminate waste. Furthermore, if the honey is granulated the baker must provide special equipment for treating and removing honey from the cans. Such equipment is generally lacking in most bakeries. It is possible that granulated honey could be packaged in more suitable form.

Another problem associated with handling is caused by the viscous, sticky properties of honey since these liquids are difficult to measure with any degree of accuracy. Sugar syrups shipped in tank cars and metered to the mixer are used in a few bakeries today. The use of a similar system for handling honey might well be employed. It would be necessary, however, to reduce the viscosity of the honey, and also prevent granulation. Another alternative would be to dehydrate the honey. However, it is unknown whether such treatment would be economically feasible.

It has been the object of the present research to study the effect of honey of various flavors and composition when used in the production of white bread, whole wheat bread and rolls. Study has been made of the relationship of honey composition, aroma and flavor to bread quality and consumer acceptability. It is the intention that such data would permit the establishment of a correlation between honey grading factors and usage in commercial baking. The use of honey in cakes and sweet goods will be the subject of a later paper.

Selection of Honeys

The 15 honeys selected for this study were chosen for their extreme variation in chemical composition, flavor and color. Individually, they are representative of the most abundantly available flavors, and those most likely to be offered to the baker. Honeys were obtained from dealers located in the area where particular flavors are known to be most abundant, thereby insuring purity of floral source. Chemical analysis of the honeys as well as U. S. Grade, floral source, and area of production are shown in Tables I and II.

Effects of Honeys on White Bread Quality

Methods.

Experiments concerning the use of honey in white bread production and on bread quality were conducted on a pilot plant scale employing acceptable commercial procedures. The sponge-dough process was employed

TABLE I—SOURCE, GRADE, COLOR, AND PARTIAL CHEMICAL ANALYSIS OF HONEYS

Floral Source	Area Source	Water	Color[1]	Grade Name[3]	Grade	Ash	Units pH
		%	mm			%	
Y. sweet clover	Kansas	17.1	25	White	A	0.07	3.9
Mesquite	Texas	17.2	32	"	A	.09	4.0
Ariz. alfalfa	Arizona	15.1	44	ext. lt. amber	A	.29	4.0
Star thistle	California	16.4	49	" " "	A	.13	3.7
Tupelo	Florida	18.8	54	" " "	C[2]	.10	3.9
Eucalyptus	California	17.7	64	lt. amber	A	.24	4.0
White clover	California	15.9	22	white	A	.07	3.8
Orange	California	16.4	21	white	A	.07	3.7
Heartsease	Iowa	17.0	50	ext. lt. amber	A	.07	4.0
Horsemint	Texas	19.8	40	" " "	C[2]	.21	3.6
Spanish needle	Kansas	18.1	73	lt. amber	A	.20	4.4
Buckwheat	New York	19.7	119	dark	C[2]	.09	3.9
Fall flowers	New York	17.8	111	amber	A	.17	4.0
Lt. amb. alfalfa	California	15.4	53	lt. amber	A	.16	3.9
Cotton	Texas	16.4	26	white	A	.18	3.9

[1] Color in millimeters Pfund.
[2] Exceed maximum moisture limits for grade "A".
[3] Ext. lt. = extra light.

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TABLE II—SUGAR ANALYSIS OF HONEYS

Floral Source	Sucrose	Levulose	Dextrose	Levulose / Dextrose	Dextrin
	%	%	%		%
Y. sweet clover	6.5	41.2	33.8	1.22	0.15
Mesquite	2.0	42.0	35.0	1.20	.20
Ariz. alfalfa	3.2	39.6	38.5	1.03	.57
Star thistle	2.3	38.9	36.6	1.06	.64
Tupelo	2.1	42.8	30.8	1.39	.25
Eucalyptus	2.2	39.8	33.8	1.17	.43
White clover	3.9	40.2	37.8	1.06	.12
Orange	7.2	40.6	35.0	1.16	.19
Heartsease	3.3	40.7	37.4	1.09	.03
Horsemint	3.7	38.7	35.7	1.08	.32
Spanish needle	3.6	43.1	31.3	1.38	1.93
Buckwheat	3.3	37.8	35.4	1.06	.54
Fall flowers	2.9	38.6	37.9	1.02	.50
Lt. amb. alfalfa	4.7	41.6	35.1	1.19	.12
Cotton	3.2	39.5	38.6	1.02	.39

using optimum conditions of absorption, mixing, fermentation, proofing, and baking. The following 70% sponge and dough formula was used:

Ingredient	*Sponge*	*Dough*
Flour	70	30
Yeast	2	—
Yeast food	0.25	—
Malt	0.25	—
Sugar	—	3.6
Shortening	—	3
Milk solids	—	4
Salt	—	2
Paniplus	—	0.5

Sucrose was used in the control formula for comparison with honey. On the basis that honey contained on the average of 82.5% sugar solids, the various honeys were substituted for sucrose. Correction of absorption for the moisture added with the honey was based on the average moisture of 17.5% for the honeys used in the study. Thus on an equivalent basis, 7.3% of an average honey was equal to 6% of sucrose in the formula. Although the various honeys vary in moisture content, the average moisture content was employed in calculations and experiments since it was desired to learn if natural variation in this factor affected the production of bread. To eliminate loss in measuring, a solution consisting of the water, honey and salt was used in the dough stage.

The bread was scored approximately 18 hours after baking, using the American Institute of Baking scoring system. This includes the following factors: volume, 10; crust color, 8; symmetry, 3; evenness of bake, 3; character of crust, 3; break and shred, 3; grain, 10; crumb color, 10; aroma, 15; taste, 20; and texture, 15.

Results of Substituting Various Honeys for Sucrose

Close observation of dough handling properties did not reveal any significant differences in absorption, mixing, fermentation, machining, proofing or baking qualities of the doughs containing honey or sucrose at either 3% or 6% levels. Alpha-amylase activity of the honeys as determined by the modified Wohlgemuth method (*Cereal Chem. 16:* 712-723, 1939) was essentially immeasurable. This shows that honey would not contribute any diastatic effects to the breadmaking process. Proteolytic activity of the various honeys was also determined using the modified Ayre-Anderson method (*J. A. O. A. C.*, Nov. 1947). Horsemint honey was highest in proteolytic activity, assaying 0.125 unit per 0.4 g of honey solids. Proteolytic activity contributed by honey would therefore be negligible in bread, even if amounts higher than 6% honey were used. It should be pointed out that honey which has not been subjected to processing by heating may contribute to the malting effects.

Since the results of baking tests at both 3% and 6% sugar levels were parallel, and in the interest of brevity, the data presented in Table III deal only with the more important aspects of the 6% level. It is sufficient to report that at the 3% level, except for a very slight effect on crumb color when buckwheat and fall flowers were used, all other characteristics of the honey breads were indistinguishable from those made with sucrose.

Small differences are noted in Table III regarding grain, texture and crumb color. Buckwheat and fall flowers honeys produced bread with texture judged to be more harsh than the others. This effect seemed to be quite consistent. Effects of other honeys on texture were indistinguishable. Crumb color was most prominently affected, being directly proportional to the color of the honey used. Crumb color was undesirable when buckwheat, fall flowers or Spanish needle honeys were used. All the bread received maximum score on volume, character and color of crust, symmetry, evenness of bake, and break and shred. It was concluded that natural variations in moisture, ash, acidity, and levulose-dextrose ratio of the honeys did not affect either the production schedule or quality of the bread.

Effect of Honey on Retention of Moisture and Crumb Firmness

Samples of bread crumb were air-dried 24 hours after which they were subjected to oven-drying at 130° C for one hour in order to determine whether honey produced any effects on moisture retention in the loaves. No significant differences were noted between the sucrose or honey breads at either the 3% or the 6% level. Obviously, any differences in levulose-dextrose ratio of the honeys was alleviated by the end of the fermentation period when most all the sugar had been consumed by the yeast.

The Bloom gelometer was employed for tests on crumb compressibility to determine if honey would produce softer bread. No significant differences were detected at either sugar level between those loaves made with honey or sucrose.

The physical tests on white bread have shown that most honeys may replace sucrose without deleterious effects on bread quality. Certain of the honeys affect crumb color, grain and texture at the 6% level as indicated in Table III. However, except for the effects on crumb color due to buckwheat and fall flowers honeys, no effects differing from those obtained with sucrose are apparent at the 3% level.

Consumer acceptability of bread made with honey. The effects of various honeys on aroma and taste of bread are of utmost importance. Organoleptic tests were performed at both 3% and 6% honey levels. The purpose of these tests was twofold; first, to determine whether or not the presence of honey in the bread could be detected by the consumer, and secondly, to determine which flavors, if any, might not meet with consumer acceptance.

At the 3% honey level, 55% of the tasting panel detected the presence of honey in bread. Statistical analysis showed this percentage to be highly

significant. When 6% honey was used, 59% of the panel detected the presence of honey in the bread. Since some of these honeys are known to be of stronger flavor than others, it can reasonably be expected that their presence would affect the percentage of judgments by the panel. Tupelo, orange, buckwheat, fall flowers and heartsease are the strongest flavored honeys. A study of results showed that these honeys were more consistently detected.

Consumer acceptance tests were also employed in an effort to determine which of the honeys might lend an offensive aroma or taste to the bread. A study of the data showed a total of 21% of all the reactions were regarded as unpleasant by the panel. Of these, 62.5% were divided among buckwheat, fall flowers, heartsease and tupelo honeys. Buckwheat and heartsease honeys were shown to be definitely undesirable, while tupelo and fall flowers were borderline cases. The tupelo honey used, while representative of the 1948-50 tupelo crop, was possibly below the long time average crop in color and flavor, due to unfavorable conditions during production. Orange honey was quite acceptable. Further consumer acceptance testing showed that buckwheat honey could be used when mixed with mild-flavored clover honey in amounts up to 10% of the blend. Tupelo, heartsease, and fall flowers could be blended with yellow sweet clover honey in amounts up to 15% and still meet with consumer approval. Use of these blends did not affect crumb color at the 6% level. It was assumed that other honeys could be blended in any proportion, since they were acceptable when used alone.

Toasting of bread containing honey. Since a portion of nearly every loaf of bread sold will be consumed as toast, the effects of toasting honey bread were also studied. Bread made with honey is exceptionally appetizing when being toasted, since the heat amplifies the aroma of honey. Buckwheat, heartsease, and horsemint honeys produced objectionable odors. Mesquite, Arizona alfalfa, tupelo, eucalyptus, Spanish needle and fall flowers were rated as only fair in aroma but nevertheless acceptable. All other honeys were good or very good. The color of the toast for all samples was desirable. No difference in appearance or palatability was apparent from slices containing sucrose or honey.

Cotton, orange, white clover, star thistle, and yellow sweet clover honeys were judged best, lending an exceptionally fine honey flavor and aroma to the toasted bread.

TABLE III—EFFECT OF HONEY TYPE ON BREAD SCORE USING 6% HONEY SOLIDS

Type of Sweetening	Volume 10	Character of Crust 3	Grain 10	Texture 15	Crumb Color 10
Sweet clover	10	3	9	14	9
Mesquite	10	3	9	14	8
Arizona alfalfa	10	3	8	13	9
Star thistle	10	3	9	13	9
Tupelo	10	3	8	13	8
Eucalyptus	10	3	8	13	8
White clover	10	3	9	14	10
Orange	10	3	9	13	9
Heartsease	10	3	9	13	9
Horsemint	10	3	8	14	9
Spanish needle	10	3	8	14	8*
Buckwheat	10	3	8	12	7**
Fall flowers	10	3	8	12	8***
Lt. amber alfalfa	10	3	9	13	9
Cotton	10	3	8	14	10
Sucrose	10	3	9	14	10

* Yellow crumb. **Brown crumb. *** Tan crumb.

Conclusions Regarding the Use of Honey in White Bread

Variation in color and flavor of honey from different floral sources is the only factor found to be important as it affects white bread production. Variations in such factors as sugar content, acidity, levulose-dextrose ratio, enzyme content, ash and dextrin contents seem to have no effect, at least within the range studied here. Standardization of honey with respect to these variables is not necessary for bread products.

Honey presents no problems in absorption, mixing, fermentation, machining, proofing or baking when used in amounts of 6% or less. The variation in the natural moisture content of the honeys falling between 15 and 20% is of no practical significance, and correction for absorption can be made by assuming an average moisture content for the honeys of 17.5%. Thus when 6% honey is used a decrease of 1% absorption will account for the moisture added with the honey. Likewise, correction for sugar content can be made by assuming that the average honey contains 82.5% sugar solids.

Other than flavor and aroma, honey does not offer any particular advantage over sucrose for use in white bread. However, the flavor and aroma of all honeys used except buckwheat, fall flowers, heartsease and tupelo are quite acceptable consumerwise. Even these are acceptable in proper blended form. Where it is desired to produce white bread with a definite honey aroma and flavor with a minimum of effect on crumb color, orange honey is very desirable.

Whole Wheat Bread

Whole wheat bread accounts for only a small percentage of the total bread produced. However, it is in this type of bread that honey has been most often used in the past, since the effects on crumb color are of no consequence. Although the results of the tests on white bread are also applicable to whole wheat bread, further testing was aimed at determination of the maximum amount of honey that could be used. Using the straight dough method, the following formula produced a good quality bread and was used throughout the whole wheat baking experiments.

Ingredients	*Percent*
Whole wheat flour	100
Dry skim milk	4
Shortening	4
Yeast food	0.25
Malt	0.5
Salt	2.25
Sugar	3
Yeast	2
Water	70

Honey was substituted for sugar in amounts of 3, 6, 9 and 12%. At the 9% and 12% levels, separate experiments were done in which yeast was increased to 3%.

Distinct honey aroma was evident in bread containing tupelo and orange honeys at all levels. Heartsease and buckwheat honeys produced bread with a musty aroma and peculiar taste. Other honeys did not produce a discernible honey aroma or flavor, but did enhance the richness of flavor. At levels of 6% and more, fall flowers and horsemint honeys had undesirable effects on aroma.

Deterioration of bread quality was observed as honey was increased beyond 6%. It is very evident that the old adage about too much of a good thing also applies to honey used in bread.

Conclusions concerning the use of honey in whole wheat bread. Pure floral sources of buckwheat, heartsease, fall flowers and horsemint honeys are not recommended for use in whole wheat bread. However, these honeys may be used in blended form as previously recommended for white bread. The use of any honey in amounts greater than 6% lowers the bread quality. Richness of flavor is enhanced by the use of honey, but if honey flavor is desired, tupelo or orange honeys would give best results. Consumer acceptance tests were not carried out on whole wheat bread, but in the opinion of the scorers tupelo honey would be as acceptable as orange honey in this type of bread.

Effect of Honey on Soft Roll Production

Doughs were made using the same basic formula as for white bread, except that various honeys and sugar were increased to 8%, shortening to 6%, and yeast to 2.5%. Dinner rolls and hamburger buns were made in order to study the effects of honey on grain. Some stickiness was observed in the doughs after mixing.

Tupelo, heartsease, horsemint, buckwheat, Spanish needle and fall flowers honeys all produced undesirable flavors. Mesquite and star thistle honeys caused tough crusts. Arizona alfalfa and orange honeys both produced very poor grain. Light amber alfalfa and sweet clover honeys produced rolls that were acceptable.

When honey flavor is desired in soft rolls, white clover or cotton honeys would be recommended. Since rolls are often reheated just prior to serving, the use of eucalyptus honey would be somewhat less desirable. The aroma of reheated products containing eucalyptus honey would be less desirable than a product containing white clover or cotton honeys. This effect was shown in the toasting experiment.

Proposed Specifications for Purchase of Honey for Use in White or Whole Wheat Bread*

1. All honey containers should be clearly labeled, showing grade, floral source, moisture content and color in mm Pfund as well as U. S. Department of Agriculture color standards.

2. Honey for bakers' use should be "U. S. Grade A" or "B", according to U. S. standards for grades of extracted honey, effective April 16, 1951.

3. The Pfund colorimeter reading should not exceed 70 mm for honey to be used in white bread.

4. Predominant floral sources of buckwheat, fall flowers, heartsease and tupelo honeys should not be used in white bread, except in blends as noted in item 6.

5. Buckwheat, fall flowers, heartsease and horsemint honeys should not be used in whole wheat bread, except in blends as noted in item 6.

6. Blends of acceptable honeys containing 10% of buckwheat, or 15% of heartsease, fall flowers or tupelo honeys are acceptable.

7. Honey should conform to Pure Food and Drug Laws for this commodity.

8. Honey for bread baking purposes should be heat-treated at 130° F for 30 minutes to retard granulation and enzyme activity.

* To serve as a guide for those who offer honey to bakers, and for those bakers who wish to purchase honey.

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